BOOKCASE 1 - SHELF 3
ITEM 2

PLEASE PLACE ITEM BACK IN
NUMERICAL ORDER. THANK YOU!

# ARIZONA DEPARTMENT OF WATER RESOURCES

## PHOENIX AMA COMPREHENSIVE HYDROLOGIC MONITORING PLAN

# FIRST ANNUAL STATUS REPORT

## SEPTEMBER, 2002

## TABLE OF CONTENTS

Purpose. ..... 1

Introduction ..... 2

Organizational Chart ..... 3

I. List of Monitoring Activities 2001 to 2002. ..... 4

Task One - Groundwater Elevation Data Collection
Introduction ..... 4
Groundwater Data Collection Site Characteristics ..... 5
Transducer Well Site Selection ..... 9
Equipment Vendor Selection ..... 9
Contractor Installation ..... 9
Ancillary Equipment ..... 10
NOAA GOES Satellite Accounts ..... 10
ADWR Database and Interactive Website ..... 10

Task Two - GPS/GRAVITY and Land Subsidence Monitoring
Introduction ..... 11
Work and Projects Performed by the GPS/Gravity Group within the Phoenix AMA ..... 11

Task Three - Crop Type and Acreage Determination
Introduction ..... 12
Work and Projects Performed by the Remote Sensing Group within the Phoenix AMA ..... 13

Task Four - Water Quality Monitoring
Introduction ..... 13
Work and Projects Performed by the Water Quality Monitoring Group within the Phoenix AMA ..... 14

Task Five - GWSI Field Database and Forms Development ..... 14

Task Six - Stream Flow Recharge ..... 15

II. Phoenix AMA Comprehensive Monitoring Plan Augmentation Funds Expenditures Fiscal Year 2002 ..... 16

III. Future Work and Planning ..... 17

Groundwater-Level Data Collection. ..... 17

GPS/GRAVITY Projects ..... 17

Remote Sensing and Crop Typing..... 18

TDS and Detailed Analysis Collection ..... 18

Stream Flow Data Collection ..... 19

DOMSAT (Domestic Satellite) System ..... 19

Database Development ..... 19

Annual Water Budget ..... 19

## APPENDICES

Appendix A..... 20
Description of the Transducer Site Selection Criteria ..... 21

Appendix B..... 23
Phoenix AMA Monitoring Project Cooperators -
Groundwater-Elevation Data Collection Task..... 24

Appendix C. ..... 25
List of Map Plates -

Phoenix AMA Upper Aquifer Thickness ..... Plate 1

Phoenix AMA Middle Aquifer Thickness..... Plate 2

Phoenix AMA Lower Aquifer Thickness ..... Plate 3

Phoenix AMA River and Stream Courses ..... Plate 4

Phoenix AMA Water Level Changes, 1995 to 2000 ..... Plate 5

Phoenix AMA Municipal Boundaries ..... Plate 6

Phoenix AMA Subsidence Zones..... Plate 7

Phoenix AMA Recharge Project Locations..... Plate 8

Phoenix AMA Irrigation and Water Companies..... Plate 9

Phoenix AMA Superfund and WQARF Sites..... Plate 10

## LIST OF TABLES

Table 1. Task Responsibility Chart ..... 3

Table 2. Current Installed Transducer Site Characteristics ..... 6

Table 3. Fiscal Year 2002 Budgetary Expenditures ..... 16

Table 4. Current Transducer Sites with Applicable Criteria..... 22

## LIST OF FIGURES

Figure 1. Typical Transducer Site Configuration with Satellite Telemetry ..... 5

Figure 2. Typical Transducer Site Configuration with No Satellite Telemetry ..... 5

Figure 3. Site AA within the Town of Queen Creek..... 6

Figure 4. Site AB within the City of Phoenix..... 6

Figure 5. Site AC at the Douglas Ranch, Hassayampa Sub-basin ..... 7

Figure 6. Site AD near the Johnson Ranch Area, SE Area of the Phoenix AMA ..... 7

Figure 7. Site AE within Sun City ..... 7

Figure 8. Site AE Equipment Configuration within the Concrete Bunker ..... 8

Figure 9. Site AG at the Boulders Area Scottsdale ..... 8

Figure 10. Site AH near the Scottsdale Airport ..... 8

Figure 11. Completed Central Phoenix Transducer Site..... 10

Figure 12. Stream Gage 51$^{ST}$ Avenue and the Salt River ..... 15

Figure 13. Stream Gage Attaway Road and the Gila River..... 15

# FIRST ANNUAL STATUS REPORT

# PHOENIX AMA
# COMPREHENSIVE HYDROLOGIC MONITORING PLAN
# SEPTEMBER, 2002

## PURPOSE

This status report provides the Phoenix Active Management Area (AMA) staff, the Groundwater Users Advisory Council (GUAC), and the general public with information on the progress made by the Hydrology Division in implementing the Comprehensive Hydrologic Monitoring Plan for the Phoenix AMA.

This status report discusses the progress made since the Arizona Department of Water Resources and the GUAC approved the plan in September 2001. It is a full and complete accounting of the Monitoring Plan and includes the following:

1. A list of monitoring tasks - 2001-2002.
   - Groundwater-elevation data collection to include: a description of newly installed and operating groundwater monitoring sites and a description of proposed transducer site selection criteria
   - GPS and gravity data collection
   - Remote sensing and crop-typing data collection
   - Total dissolved solids (TDS) and common ion data collection
   - Field database and forms development
   - Stream flow data collection

2. An accounting of all monies expended from the Phoenix AMA Augmentation Fund for Fiscal Year 2002.

3. An accounting for the distribution of labor for Fiscal Year 2002.

4. A list of cooperators having joined this project.
   - Groundwater-elevation data collection

5. A description of future work remaining.
   - Groundwater-elevation data collection
   - GPS and gravity data collection
   - Remote sensing and crop-typing data collection
   - Total dissolved solids (TDS) and common ion data collection
   - Database development
   - Stream flow data collection
   - DOMSAT (Domestic Satellite) system
   - Annual water budget

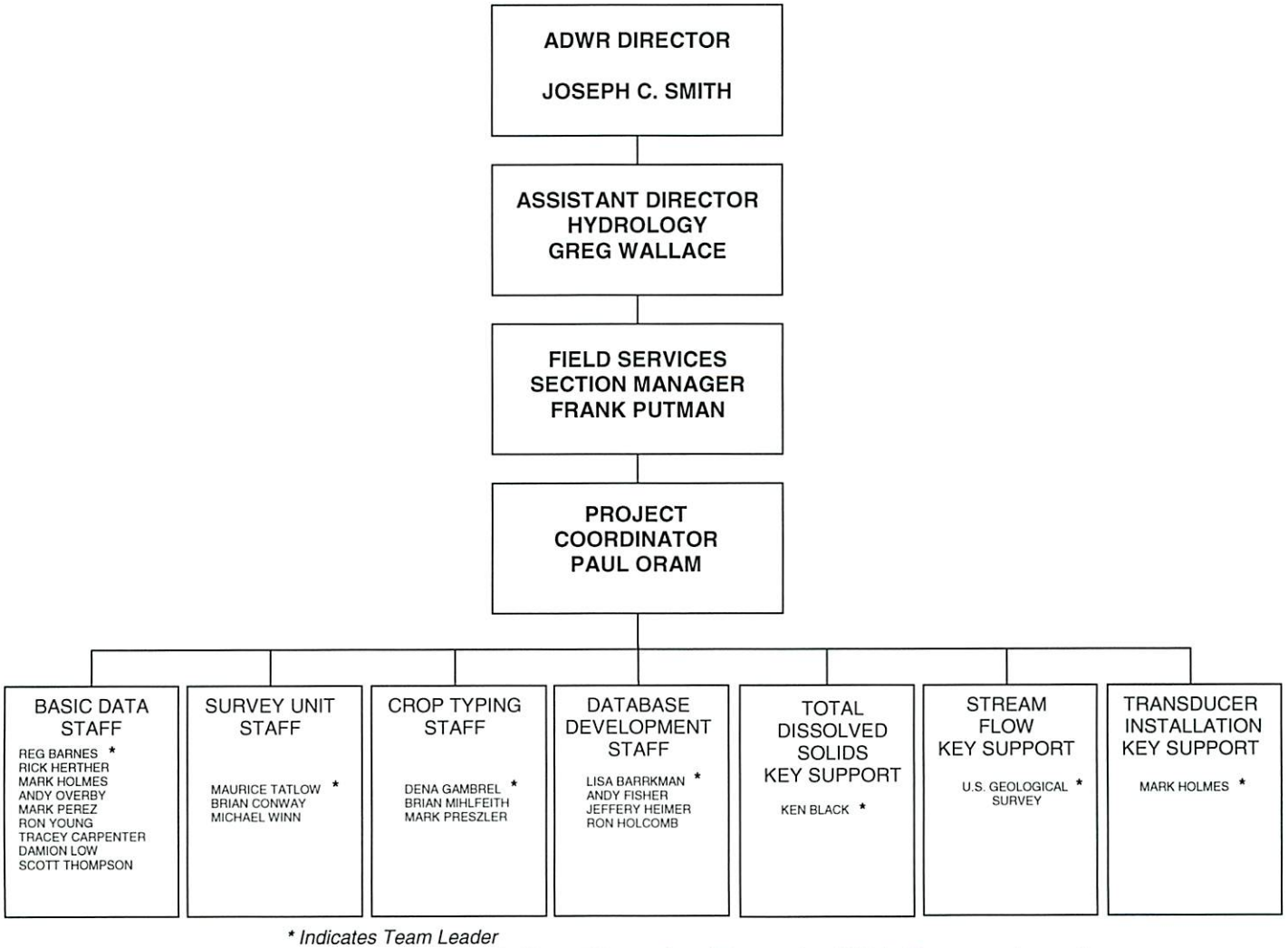
## INTRODUCTION

The Arizona Department of Water Resources (ADWR; Department) and its cooperators throughout the state have conducted groundwater-monitoring activities for many years. As part of the dialog with the Governor's Water Management Commission (Commission), it became apparent that there exists a need for an increased level of monitoring of hydrologic conditions in the Phoenix AMA. The emphasis on monitoring from the Commission and funding from the Phoenix AMA Augmentation Fund affords the Department the opportunity to design and implement a comprehensive hydrologic monitoring program.

This program is not limited to the collection of groundwater data alone, as has been the case in the past, but includes the collection of surface water data, subsidence data, gravimetric data and water use data. This will give the Department the ability to construct more timely and more accurate water budgets, and monitor the hydrologic behavior of the AMA with greater efficiency.

This comprehensive monitoring plan was designed to be implemented in three phases to allow monitoring work to be achieved with available staff and funding. At the end of three years, the system will be complete and system maintenance will be an ongoing activity. The experience gained in the Phoenix AMA will allow the development of a comprehensive monitoring plan for each of the other AMAs as well.

## TASK RESPONSIBILITY CHART




** Indicates Team Leader*

***Table 1. Task Responsibility Chart for Phoenix AMA Comprehensive Monitoring Plan***

# I. LIST OF MONITORING ACTIVITIES 2001 TO 2002

Activities for 2001-2002 (Year 1) were divided into specific tasks that could be performed by the various teams from the Field Services section and other staff within the Department. These tasks include groundwater-elevation data collection, GPS and gravity data collection, remote sensing and crop-typing data collection, total dissolved solids (TDS) and common ion data collection, stream flow data collection, and database development.

## TASK ONE

## GROUNDWATER ELEVATION DATA FROM TRANSDUCERS, INDEX WELLS, AND NEW MONITORING WELLS

Introduction

The current water-level index program involves the annual measurement of about 350 wells in the Phoenix AMA. This will increase to approximately 400 wells. This increase will concentrate in developing areas of the AMA, in areas of high water-level change, where land subsidence is occurring, or in other special consideration areas. Revision of the index well network will include measurement of more wells that represent specific aquifer units and the installation and use of continuous recording, digital pressure transducers (transducer sites) at 65 to 70 locations. Each year between 20 to 23 transducers will be installed for a combined total of 70 transducer sites throughout the Phoenix AMA. Of the total sites, 40 will have Geostationary Operational Environmental Satellite (GOES) data transmitters and the remaining sites will be visited and data downloaded manually from the data-logger.

Limited staff availability requires this work to be completed in several phases, with each phase taking one year to complete. Experience in the Prescott and Santa Cruz AMAs has shown that approximately 20 new transducer sites can be installed per year with existing staff. More transducers per year will be installed in later phases of this plan with the experience gained.

Year 1 included the acquisition and installation of eight transducer sites and the continued measurement of the 350 current water-level index wells. Other activities were as follows: review current water-level index lines, locate wells and obtain letters of agreement for transducer sites. Years 2 and 3 will be similar in scope.

Year 4 and after will consist of maintaining the index lines and transducer sites and replace faulty transducers systems as needed. Areas where water-level information is critical will be evaluated each year beginning in Year 4 and additional transducer sites will be installed.

***Figure 1. The typical transducer site configuration with satellite telemetry***

***Figure 2. The typical transducer site with low profile aesthetics and no satellite telemetry***

To date, eight transducer sites have been installed throughout the Phoenix AMA. Seven of these sites are transmitting data using satellite telemetry (See Figure 1); however, the remaining site does not because of community aesthetics (See Figure 2). These sites were chosen based on several criteria discussed later in this report (See Appendix A, Page 21, and Appendix C, Map Plates 1-10). All transducers are recording date, time, depth to groundwater, groundwater temperature, and system battery voltages every six hours. Some transducers will have the data collected manually and posted to the Groundwater Site Inventory (GWSI) manually. The transducer data being transmitted via satellite is using the National Oceanic and Atmospheric Administration (NOAA) GOES System to send the data once per day at an assigned transmission time. The telemetry data is currently queried through the NOAA Internet or Telnet websites, captured, and then uploaded into a data table where both the manually downloaded and satellite transmitted data are to be used by the Department's website.

Current groundwater data collection site characteristics

Table 2 on page 6 briefly describes the characteristics and parameters of the installed groundwater data collection sites. Figures 3 through 10 on pages 6 through 8 are images from the eight completed sites within the Phoenix AMA.

| SITE ID | LOCATION | WELL ALTITUDE | WELL DEPTH | SATELLITE TELEMETRY | LOGGING RATE |
|---|---|---|---|---|---|
| AA | D-02-07 22BBC | 1403 | 606 | YES | 6 HOURS |
| AB | A-02-03 09CDA | 1177 | 255 | YES | 6 HOURS |
| AC | B-04-05 01CBA | 1600 | 1000 | YES | 6 HOURS |
| AD | D-04-09 05AAD | 1551 | 900 | YES | 6 HOURS |
| AE | A-03-01 04DBB | 1192 | 910 | YES | 6 HOURS |
| AF | A-02-04 01ACC | 1298 | 1800 | YES | 6 HOURS |
| AG | A-05-05 05CAA | 2680 | 1505 | NO | 6 HOURS |
| AH | A-03-04 11CBA | 1448 | 1200 | YES | 6 HOURS |

***Table 2. Groundwater-data collection site characteristics***

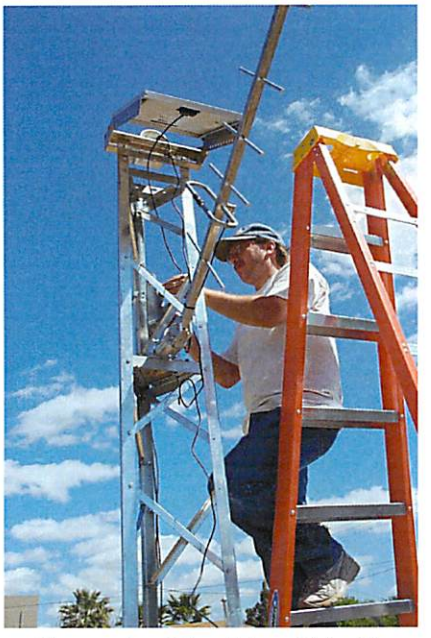


***Figure 3. Site AA within the Town of Queen Creek***

***Figure 4. Site AB within the City of Phoenix***

*Figure 5. Site AC at the Douglas Ranch, Hassayampa Sub-basin*

*Figure 6. Site AD near the Johnson Ranch Area (Arizona Farms Road), SE area of the Phoenix AMA*

*Figure 7. Site AE in Sun City*

*Figure 8. Site AE equipment configuration within the concrete bunker*

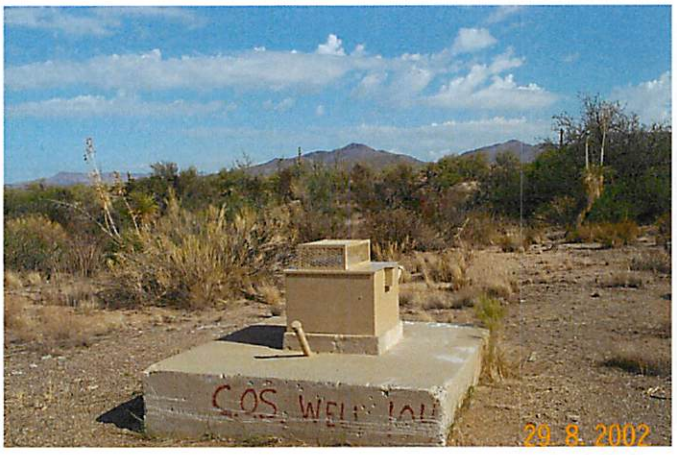



*Figure 9. Site AG near the Boulders (No Satellite Telemetry)*

*Figure 10. Site AH near the Scottsdale Airport*

Sites AF, AG, and AH are located within the City of Scottsdale (**Note: No picture available for Site AF)**

## Transducer Well Site Selection

A Groundwater Site Inventory (GWSI) database query was developed to generate a list of unused and unequipped well sites throughout the Phoenix AMA as potential transducer candidates. Each well site was then visited and inventoried by Basic Data staff. If the well was unused and unequipped it received a database code which enabled it to be pulled from the database and placed on a Geographic Information System (GIS) map. Each of these potential transducer sites was then applied to a criteria selection process and evaluated for water-level fluctuations, aquifer penetration, multiple aquifers, proximity to known subsidence zones, areas of major land development, proximity to groundwater recharge projects, and proximity to EPA Superfund and WQARF sites (See Appendix A, Page 22).

A letter of agreement was drafted following the Department of Administration's Risk Management guidelines and sent to the owners of the candidate sites along with an explanation of the monitoring program and a schematic diagram of the transducer site. To further expand the pool of potential transducer sites, the same information was sent to Phoenix AMA municipalities, irrigation districts and water companies. Entities interested in the project then provided a list of candidate wells for ADWR to further evaluate (See Appendix B, Page 24).

## Equipment Vendor Selection

Vendors were contacted for a demonstration of various types and costs of water-level monitoring equipment. ADWR staff also attended a symposium in Tucson yielding valuable information about other technologies, equipment, and vendors. Design Analysis Associates, Inc. of Logan, Utah were chosen to supply water-level monitoring equipment and provide training. Design Analysis' equipment has a proven track record for reliability, and has satellite ready telemetry. Equipment costs are competitive and comparable with other vendors. Their customer support and in-house training has also been excellent.

## Two Transducer Sites Selected for Contractor Installation

ADWR contracted with Design Analysis, Inc. to provide training and two turnkey transducer site installations with satellite telemetry. This provided ADWR staff with proper training to accomplish overall site configuration and preparation, equipment installation and site operation. The first site, located in the southeast part of the Phoenix AMA at Queen Creek, was selected because of the area's rising groundwater elevations and the increasing land development. The second site, located in central Phoenix, was chosen primarily to document decreasing groundwater elevations in that region (See Figure 11, Page 10).

***Figure 11. Completed central Phoenix transducer site. Note: Antenna mast for satellite telemetry and solar panel for battery recharging***

Ancillary Equipment Purchasing and Fabrication

The first year's ancillary equipment was identified and purchased. This equipment typically consists of a steel shelter to house the electronic equipment, solar panels, gel cell batteries, antenna mast material and various nuts and bolts. Each successive year's ancillary equipment will be purchased as needed.

Each site requires in-house and on-site fabrication of some components due to site-specific dynamics and local aesthetics laws that may vary for each city and demographic area.

(NOAA) GOES Satellite Account Authorization

Satellite telemetry will be installed on about half of the transducer sites. A formal GOES DCS (Data Collection System) Use Agreement between ADWR and NOAA was created and signed into action through the NOAA NESDIS (National Environmental Satellite Data and Information Service). This contract is valid through May 31, 2004 and must then be renewed every three years.

An initial request was made and filled for twenty DCP (Data Collection Platform) accounts that provide an identification number and time window for transmitting groundwater data through the GOES satellite. An additional request for 20 more DCP accounts is nearly finalized.

ADWR Database Development and Interactive Transducer Website

The ADWR Information Technology Division (ITD) has created an upload utility that enables field and telemetry transducer data to be quality checked and quickly uploaded to the ADWR Groundwater Site Inventory data tables.

ITD is currently working on an interactive website that will allow Internet users to query both real-time and historical transducer data within the Phoenix AMA.

## TASK TWO

## GPS/GRAVITY AND LAND SUBSIDENCE MONITORING

Introduction

Land subsidence is a well-documented effect of extensive groundwater depletion and has been studied in the Phoenix, Pinal, and Tucson AMAs, Las Vegas, Nevada, California, Texas, Mexico, and many other areas of the world. Monitoring of specific areas of subsidence through Global Positioning Systems (GPS) surveys of land elevation changes and gravimetric measurements of changes in water stored in the aquifer will allow the Department to anticipate subsidence problems and design appropriate management programs. Use of satellite imagery (Interferograms) is also being used to better map and understand subsidence patterns on a regional scale (See Appendix C, Plate 7).

The GPS/Gravity Survey group of the Field Services Section of the ADWR is performing aquifer storage monitoring and subsidence monitoring surveys within the Phoenix AMA.

In addition to performing gravity and GPS surveys the GPS/Gravity Survey group is partnering with other groups that have interest in monitoring land subsidence, fissure formation and development, and aquifer storage change. These groups include the Maricopa County Flood Control District (MCFCD), the Maricopa Department of Transportation (MCDOT), The Central Arizona Project (CAP), the City of Scottsdale, the National Geodetic Survey (NGS), and the National Aeronautics and Space Agency (NASA). Working with these groups allows ADWR to maximize the benefit of monitoring efforts and minimize the cost.

Work and Projects Initiated in 2001-2002

Pool 24 Central Arizona Project (CAP)/Arizona State University (ASU) project in NE Scottsdale: Real Time Kinematic (RTK) GPS and Gravity surveys to support study of subsidence in this area. Primary surveys are complete, gravity data is to be interpreted by ASU graduate geology student (Paul Ivanich). Other hydrogeologic and geophysical investigations are being planned by CAP in this area

East Valley CAP project: Static GPS surveys performed in conjunction with CAP to determine the magnitude and rates of subsidence that have occurred along the east valley CAP canal alignment over the last 30 years. ADWR was provided a report written by Geodetic Surveying Services for CAP documenting the survey results.

North Indian Bend Wash (NIBW) subsidence project: Static and RTK GPS surveys performed to determine whether subsidence was occurring in the NIBW area. Presentation prepared and given at a concerned citizen's meeting in

Scottsdale. The GPS/GRAV group is working with the City of Scottsdale's surveying group and water resources groups to determine when/if additional surveys of the area are required.

HAWK ROCK GPS survey: Static GPS surveys of the Hawk Rock area in east Mesa/Apache Junction have been performed over the last three years. The project is on going with annual surveys performed during August/September. Data have been distributed to several consultants upon request. The GPS/GRAV group is working closely with the Maricopa County Flood Control District (MCFCD) on the project as they have multiple flood control structures in this area.

Toyota Test Track project in western AMA: There is an on-going static GPS survey of three National Geodetic Survey (NGS) Type-A monuments put in place by the test track facility. The monuments have been included within the Phoenix AMA aquifer storage monitoring network.

Water Quality Assurance Revolving Fund (WQARF) project: Estes RTK GPS survey for WQARF support.

Absolute gravity: The group supports NGS absolute gravity measurements at three sites within the Phoenix AMA and one site within the Pinal AMA. Surveys have been performed annually for the last few years and are support for the aquifer storage-monitoring program. Project is on-going.

Minor support of Interferometric Synthetic Aperture Radar (INSAR) from Center for Space Research (CSR) group: Coordinated with Dr. Sean Buckley of the CSR group regarding data formats and final products from his Conservation/Augmentation grants project. Preliminary and final reports written for both the Phoenix and Tucson AMA. Products generated through this project have been distributed to several city, county, and state groups, as well as numerous consulting firms.

## TASK THREE

## CROP TYPE AND ACREAGE DETERMINATION

### Introduction

A remote sensing strategy is being implemented to facilitate the acquisition of agricultural data to allow more accurate estimates of water use and recharge. In the Phoenix AMA, the acquired data will include the number of acres in agricultural production and the type of crop use. The data will eventually aid in analyzing specific water use and allocations in order to improve the accuracy of the water budget.

Work and Projects Performed in 2001-2002

ADWR is currently working with remote sensing specialists from the U.S. Bureau of Reclamation to implement the Lower Colorado River Accounting System (LCRAS) methodology in the Phoenix AMA.

Initially, high-resolution color satellite imagery was obtained to delineate agricultural fields and boundaries. The fields were digitized, given unique identification numbers, and stored in a database. Landsat 5 and Landsat 7 satellite images were used to discriminate between crop groups and agricultural land use. This process utilizes ERDAS's IMAGINE® software in classifying crops depending on the reflective value of each digital pixel, or signature.

Part of the process involves field verifying approximately 15 percent of the agricultural fields. The field verification or groundtruthing will be scheduled in conjunction with satellite passes. The ground reference data is used in the image classification process to improve accuracy. Optimally, imagery processing and groundtruthing will take place three to four times per year in order to capture the seasonal variation of all agricultural land use.

ADWR Field Services staff surveyed about one half of the agricultural acreage in the Phoenix AMA in July and August. The field survey data are currently being compared with Landsat and ground-truth data to determine crop types and cropped acreage.

## TASK FOUR

## WATER QUALITY MONITORING

Introduction

ADWR has broad water-quality concerns related to the suitability of water for various use sectors. There has been concern expressed that importation, use and subsequent recharge of CAP water may add to the accumulated salt load in the aquifer over time. This is one example of how the overall quality of water may affect its utilization.

The USGS and ADWR have collected thousands of specific conductance samples over the years; this approach will be expanded to allow a broad view of water-quality conditions by very inexpensive means. Specific conductance is a field measurement that is closely related to the total dissolved solids (TDS) content of water. TDS is a broad measurement of the salt load of water. The Department also currently collects basic information on groundwater quality on a regional scale from the water quality index wells. Fifty to 100 wells will be randomly sampled for specific conductance per year over the entire AMA and

occasional sampling of the flows in the Salt and Gila Rivers will be conducted to monitor TDS levels in the groundwater and surface waters of the AMA.

Work and Projects Performed in 2001-2002

The GWSI database was queried to determine which wells were sampled in previous USGS and ADWR groundwater studies. These previously sampled wells were targeted first to provide chronological water-quality data. Wells with close proximity to recharge projects, CAP recharge areas, or large groundwater irrigators within the Phoenix AMA were also sampled.

A total of 17 samples were collected for detailed analysis this past year at wells that had previously been sampled. A detailed water quality analysis provides major ions and trace metals found in a water sample. A comparison can then be made between the earlier and more recent analyses to determine if there are any changes in water quality.

An annual TDS index line has been developed to collect water-quality data within the Phoenix AMA. About 50 wells were sampled in the first year of this project. Water providers will be contacted to determine what existing TDS data they have available. This new TDS data will be incorporated into the water-quality database.

## TASK FIVE

## GWSI FIELD DATABASE AND FORMS DEVELOPMENT

A crucial part of this monitoring program is the ability to interact with the Department's groundwater database and manipulate data while in the field. The ITD and Hydrology Divisions are involved in a combined effort to design and implement a field-interactive database application allowing Field Services personnel to enter field-collected data directly into the GWSI. This data enhancement will eliminate the need for transcribing data from field forms to coding sheets before the data is input to the GWSI. This will effectively cut two steps in the transcription process and greatly reduce the errors and time associated with transcribing data. The ability to access the GWSI database and scanned well completion reports while in the field will greatly increase quality and decrease errors associated with new well database records. This new field data collection system will be implemented in the winter of 2002-2003.

## TASK SIX

## STREAM FLOW RECHARGE

The U.S. Geological Survey (USGS) was enlisted under the ADWR/USGS cooperative agreement to construct and operate new stream-gaging stations in the Phoenix AMA. After conferring with the USGS, it was determined that two stations would be constructed and placed into operation during the plan's first year. These two new stations will help bolster the more than 100 stream-gaging stations already in place within the Phoenix AMA. The Maricopa County Flood Control District and the USGS operate these gage sites in cooperation with ADWR, Salt River Project (SRP) and other agencies.

The two stream-gaging stations have been completed and are currently in operation. One stream-gage is located at the 51st Ave. bridge crossing on the Salt River in Phoenix (See Figure 12) and the second is located at the Attaway Rd. bridge crossing on the Gila River in Pinal county just south of the Phoenix AMA (See Figure 13). The two stations are equipped with pressure transducers and data loggers to record data and are radio equipped for real-time data transmission using the GOES domestic satellite transmission system. The USGS will maintain local website links to each of the gaging stations where data will be made available to the public.

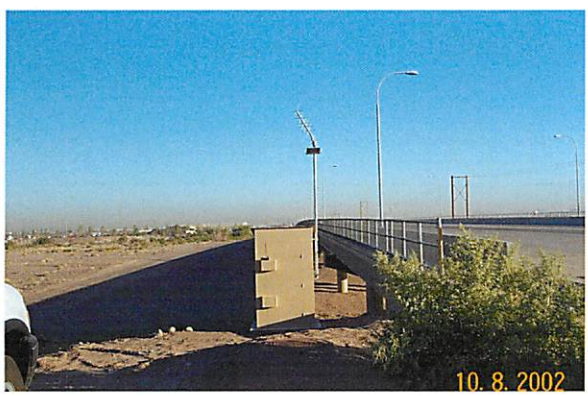



***Figure 12. USGS/ADWR stream gage at 51ST Ave and the Salt River***

***Figure 13. USGS/ADWR stream gage at Attaway Rd. and the Gila River***

## II. PHOENIX AMA COMPREHENSIVE MONITORING PLAN AUGMENTATION FUND EXPENDITURES FISCAL YEAR 2002

| DESCRIPTION | TOTAL COSTS |
|---|---|
| **PERSONNEL SERVICES** | |
| WATER-LEVEL DATA COLLECTION | $7,242.98 |
| SURFACE WATER MEASUREMENT | $579.49 |
| GRAVITY AND GPS MEASUREMENT | $895.63 |
| TDS MONITORING | $6,709.83 |
| REMOTE SENSING | $1,761.23 |
| DATABASE DEVELOPMENT | $5,504.18 |
| PROJECT COORD. & REPORT PREP. | $36,751.96 |
| TRANSDUCER INSTALLATION | $28,456.39 |
| MISC. | $66,543.81 |
| **SUBTOTAL P/S** | **$154,445.50** |
| | |
| PROFESSIONAL AND OUTSIDE SERVICES | $78,325.00 |
| | |
| TRAVEL | $4,204.37 |
| | |
| OTHER OPERATIONAL EXPENDITURES | $24,817.88 |
| | |
| EQUIPMENT | $332,146.08 |
| | |
| INDIRECT COST | $46,050.00* |
| | |
| **TOTAL COSTS** | **$639,988.83** |

*4TH QUARTER INDIRECT COST OF $46,552 WAS POSTED TO FISCAL YEAR 2003.

**Table 3. Fiscal year 2002 budgetary expenditures**

Professional and outside services expenditures were used to contract with the USGS to install and maintain two stream gages within the Phoenix AMA and provide data to ADWR.

Equipment expenditures reflect the purchase of all transducer and telemetry equipment for the entire project. Design Analysis' manufacturing warranties will start on the date when equipment is installed. A gravimeter was purchased for the GPS/GRAV group and also appears in the equipment total.

# III. FUTURE WORK AND PLANNING

Groundwater-Level Data Collection

- Install between 50-60 transducers in wells by the end of September 2004. ADWR will continue installing pressure transducers for groundwater data collection systems throughout the Phoenix AMA using current selection criteria in Appendix A.
- Locate critical areas within the Phoenix AMA where groundwater data collection is essential but no existing well sites are available. These locations will become candidate monitoring well installation sites.
- Investigate and locate new transducer site candidates throughout the Phoenix AMA and solicit participation from new entities and acquire signed letters of agreement.
- Implement data downloading automation with telemetry data sent from GOES satellites through a DOMSAT satellite receiver system.
- Field Services and Information Technology Division staff will finalize the ADWR data collection website for users to access groundwater data for both real-time and historical purposes.
- There are approximately 350 water-level index wells in nine books throughout the Phoenix AMA. These wells will be measured annually and the data entered into the GWSI database. The existing index wells/books will be evaluated and updated as needed. Abandoned wells or wells with impaired access will be replaced. Fifty new water-level wells will be added to bolster the Phoenix AMA index lines throughout all three phases of the monitoring program. Therefore, more than 15 new water-level wells will be added annually.
- The collection of a Phoenix AMA, basin-wide, water-level measurement sweep is scheduled for November 2002 through January 2003. The Basic Data and Surface Water staff will collect as many water levels as possible within that time period. New wells will replace older wells that have been abandoned and indexed in previous basin sweeps so that comprehensive and widespread water-level coverage is obtained.
- Prepare a Phoenix AMA water-level index well report to include the entire Phoenix AMA GWSI well inventory, their locations, and the data with each well. This report will include graphs and data pertaining to each well site.

GPS/GRAVITY Projects

Current projects underway that support this monitoring effort include:

- HAWK ROCK GPS survey: RTK GPS survey of the Hawk Rock area.
- Gravity Survey Phoenix Geodetic Densification And Control (GDACs) network: The baseline aquifer storage monitoring survey for the Phoenix AMA

was completed in April 2002. The next survey is planned for 2003 at the same time of year.

- GPS Survey Phoenix GDACs network (to be performed). A static GPS survey of all stations used in the Phoenix AMA aquifer storage monitoring network. Initial positions for these GDACs monuments were established two years ago, so the first survey of these monuments will determine if there has been movement over the last two years.
- NASA grant INSAR project: Support for the NASA grant will include project management, presentations, yearly reports, GPS ground truthing, and performance of annual workshops. This is the first year of the three-year grant. An Arizona Geographic Information Council (AGIC) conference presentation was performed on August 6, 2002 and an Arizona Hydrological Society (AHS) Symposium presentation was given on September 18, 2002 outlining the purpose and progress of the grant to the user community.
- Absolute gravity: Continuation of annual absolute gravity surveys in the AMA.
- GPS survey of transducer network (to be performed): Static or RTK surveys of all transducer sites to provide an accurate position and height.
- Gravity Surveys at transducer network (to be performed): Gravity surveys performed between absolute stations and transducer sites to correlate depth-to-water changes to changes in absolute gravity.
- Gravity and RTK GPS surveys near McMicken Dam: These surveys are being performed in conjunction with the Maricopa County Flood Control District (MCFCD) and their consultant (AMEC) to better define the shallow subsurface geological structure in this area and how if affects fissure formation and land subsidence patterns.

Remote Sensing and Crop-Typing

- LandSat image processing and groundtruthing will take place three to four times per year in order to capture seasonal crop variations and to determine when agricultural land goes in and out of production. A full summary of the Phoenix AMA's cropped acreage is planned for October and November of 2002 and again in the spring and summer of 2003.

TDS and Detailed Analysis Collection

- Organize new TDS Index line. All TDS data obtained from the sampled wells, existing TDS data sheets, sketches, and photos will be assembled. The index sheets will be organized into a single book so that all Field Service's personnel can locate and collect the TDS samples. The sampling point coverage will continuously be improved with each phase of the monitoring plan.

- A detailed water quality analysis provides major ions and trace metals found within a water sample. The annual water quality index line primarily evaluates water samples for major ions. A more detailed water quality sampling will be

considered throughout the Phoenix AMA under this comprehensive monitoring plan.

- Prepare a Phoenix AMA water quality report to be included in the Phoenix AMA Comprehensive Monitoring Plan Annual Report for Year 2. The annual report will include water quality index well locations, descriptions of the index wells, and water quality analysis. This report will include graphs and data pertaining to major ion changes, and detailed trace metal analyses.

Stream Flow Data Collection

- ADWR in cooperation with the USGS will continue to monitor the data from the two new stream gages installed on the Salt and Gila Rivers in 2002. In addition ADWR will utilize this data along with that of other stream gages throughout the Phoenix AMA to help formulate a more accurate water budget.

DomSat (Domestic Satellite) System

- ADWR will install a Domestic Satellite (DOMSAT) receiver system at the Department's main office in December of 2002. This installation will give ADWR the ability to receive satellite-transmitted data directly from the NOAA NESDIS facility. Receiving and storing data directly means that ADWR can receive and store a continuous stream of data without having to query the NESDIS website thereby saving manpower time and money. The NESDIS facility is not a data depot and their policy is to store data for their website for a maximum of three days after which time the data is overwritten. It also means that ADWR will not lose valuable data when and if the website is "down" for any length of time.

Database Development

- Hydrology Division and ITD staff will continue a combined effort to design and implement a field interactive database-utility allowing field personnel to enter field-collected data directly into the GWSI.

Annual Water Budget

- ADWR will produce a comprehensive and detailed 2nd Annual Status Report using the data collected and evaluated during the second year of this monitoring plan. These data will be used by the Hydrology Division to produce a more accurate and more complete annualized water budget for the Phoenix AMA.

# APPENDIX A

# DESCRIPTION OF TRANSDUCER SELECTION CRITERIA

## DESCRIPTION OF TRANSDUCER SITE SELECTION CRITERIA

The Phoenix AMA transducer locations are based on a set of criteria to achieve the best overall spatial coverage in two- and three-dimensional parameters, and in key groundwater areas throughout the AMA. The criteria are as follows:

1. Well casing perforated in upper, middle or lower aquifer units (See Appendix C, Plates 1,2, & 3)
2. Proximity to a Major stream channels (See Appendix C, Plate 4)
3. Large water-level changes occurring within a five-year period (See Appendix C, Plate 5)
4. Municipalities which have provided transducer candidate sites (See Appendix C, Plate 6)
5. Proximity to a known subsidence zone (See Appendix C, Plate 7)
6. Proximity to a recharge project or recharge zone (See Appendix C, Plate 8)
7. Irrigation companies which have provided transducer candidate sites (See Appendix C, Plate 9)
8. Proximity to EPA Superfund or Water Quality Assurance Revolving Fund (WQARF) sites (See Appendix C, Plate 10)
9. Areas of anticipated development or urbanization

| CRITERIA | SITES | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | AA | AB | AC | AD | AE | AF | AG | AH |
| PERFORATED IN UPPER AQUIFER | YES | YES | NO | UNKNOWN | YES | NO | NO | YES |
| PERFORATED IN MIDDLE AQUIFER | YES | NO | YES | UNKNOWN | YES | NO | NO | YES |
| PERFORATED IN LOWER AQUIFER | NO | NO | NO | UNKNOWN | NO | YES | YES | YES |
| PERFORATED IN MULTIPLE AQUIFER | YES | NO | NO | UNKNOWN | YES | NO | NO | YES |
| CLOSE TO WATERCOURSES | YES | YES | NO | NO | YES | YES | NO | NO |
| WATER LEVEL UP/DOWN LAST 5 YEARS | UP | DOWN | UP | UP | DOWN | DOWN | DOWN | UP |
| WITHIN A MUNICIPALITY | YES | YES | NO | NO | YES | YES | YES | YES |
| WITHIN OR NEAR A SUBSIDENCE ZONE | NO | NO | NO | NO | WITHIN | NEAR | NO | WITHIN |
| NEAR A RECHARGE AREA | YES | NO | NO | NO | YES | YES | YES | YES |
| WITHIN AN IRRIGATION DISTRICT | YES | YES | NO | YES | NO | NO | NO | NO |
| WITHIN OR NEAR A WQARF SITE | NO | YES | NO | NO | NO | NO | NO | NO |
| WITHIN OR NEAR A SUPERFUND SITE | NEAR | NEAR | NO | NO | NO | NEAR | NO | NO |

**Table 4. Current Transducer Sites with Applicable Criteria**

**See Appendix C for Map Plates showing Transducer Site Placement**

# APPENDIX B

# PHOENIX AMA MONITORING PROJECT COOPERATORS

## COOPERATORS IN ADWR'S GROUNDWATER ELEVATION DATA COLLECTION TASK

The following is a list of participants that have signed ADWR's letter of agreement for joint-use of their well site(s) for the purpose of installing transducer, data logger, and telemetry equipment for water level monitoring.

| | |
|---|---|
| 1. Arizona-American Water Company | Signed March 18, 2002 |
| 2. Queen Creek Water Company | Signed March 27, 2002 |
| 3. Rose Lane Elementary School | Signed April 08, 2002 |
| 4. Douglas Land Corp. L.L.C. | Signed April 22, 2002 |
| 5. Baxter Farms, L.L.C. | Signed April 30, 2002 |
| 6. Brian Nichols | Signed May 05, 2002 |
| 7. City of Scottsdale | Signed May 17, 2002 |
| 8. Gary Bulechek | Signed May 20, 2002 |
| 9. City of Tempe | Signed August 09, 2002 |
| 10. City of Phoenix | Signed August 29,2002 |

The following is a pending list of participants with whom the Department is currently negotiating an agreement.

1. Salt River Project
2. City of Glendale
3. City of Peoria
4. City of Mesa

Other well owners will be contacted during the course of the project.

# APPENDIX C

# MAP PLATES SHOWING TRANSDUCER SELECTION CRITERIA

MAP OF PHOENIX AMA ILLUSTRATING UPPER AQUIFER THICKNESS IN FEET

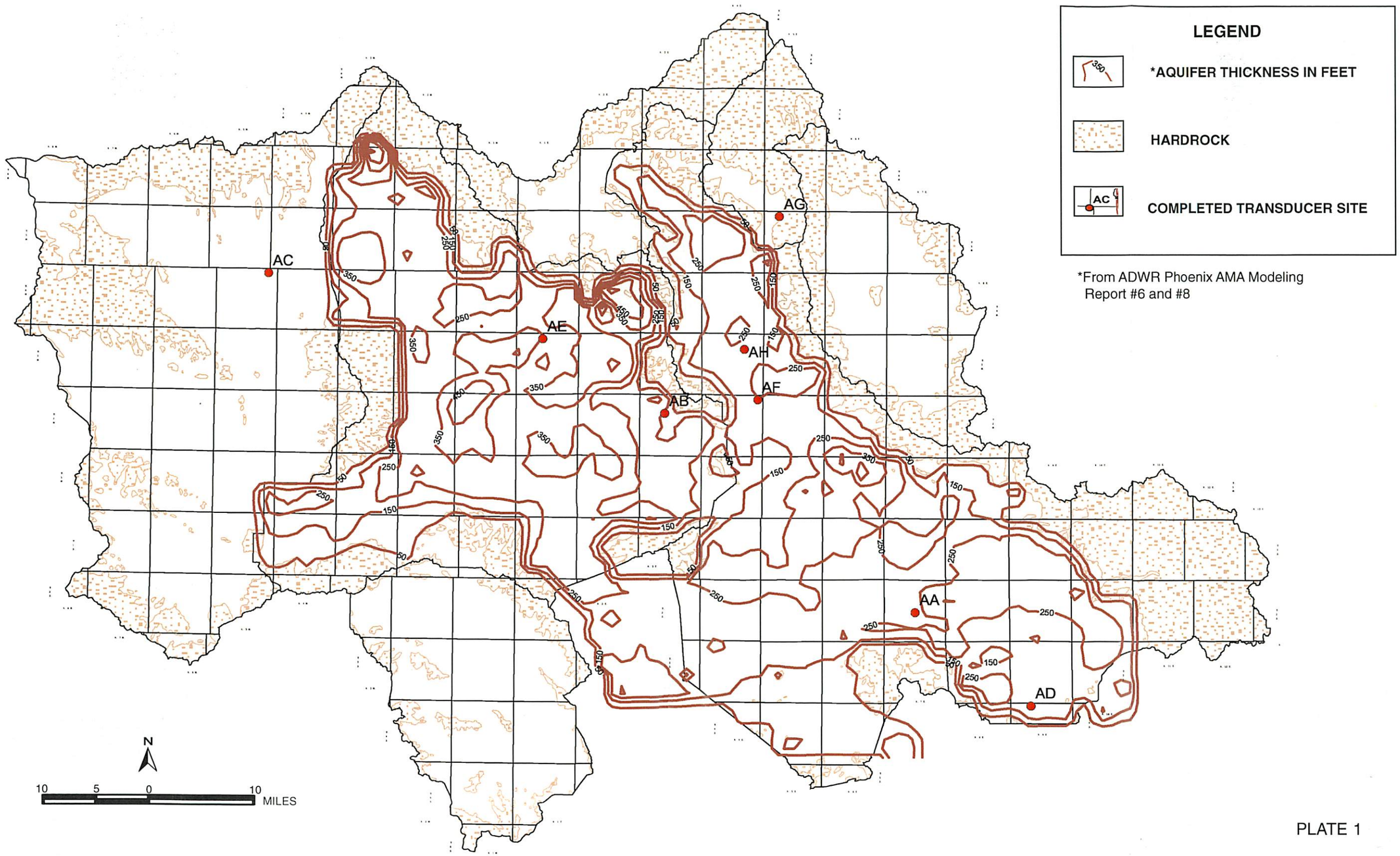
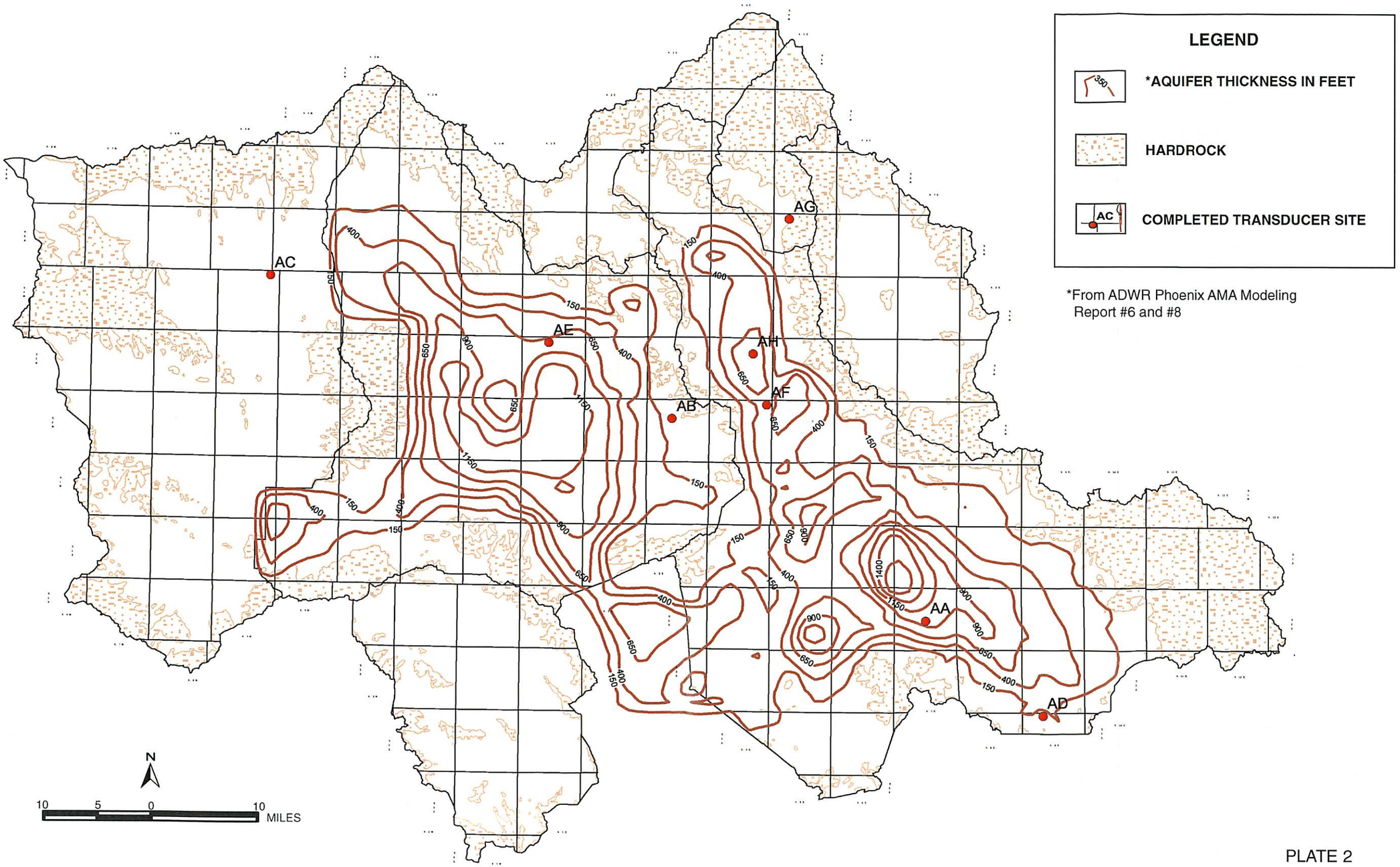



PLATE 1

MAP OF PHOENIX AMA ILLUSTRATING MIDDLE AQUIFER THICKNESS IN FEET




*From ADWR Phoenix AMA Modeling Report #6 and #8

PLATE 2

MAP OF PHOENIX AMA ILLUSTRATING LOWER AQUIFER THICKNESS IN FEET

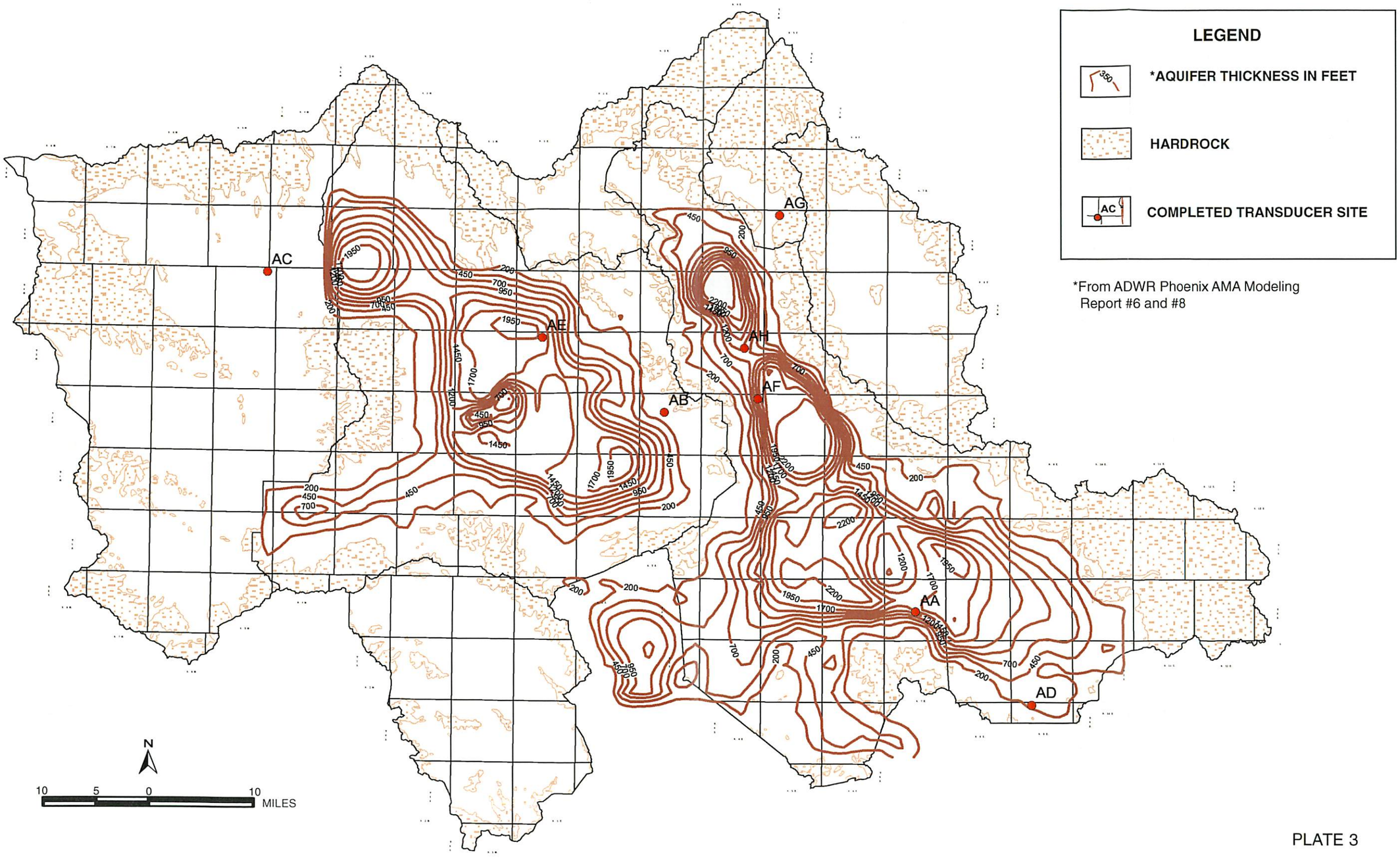



PLATE 3

MAP OF PHOENIX AMA ILLUSTRATING RIVER AND STREAM COURSES

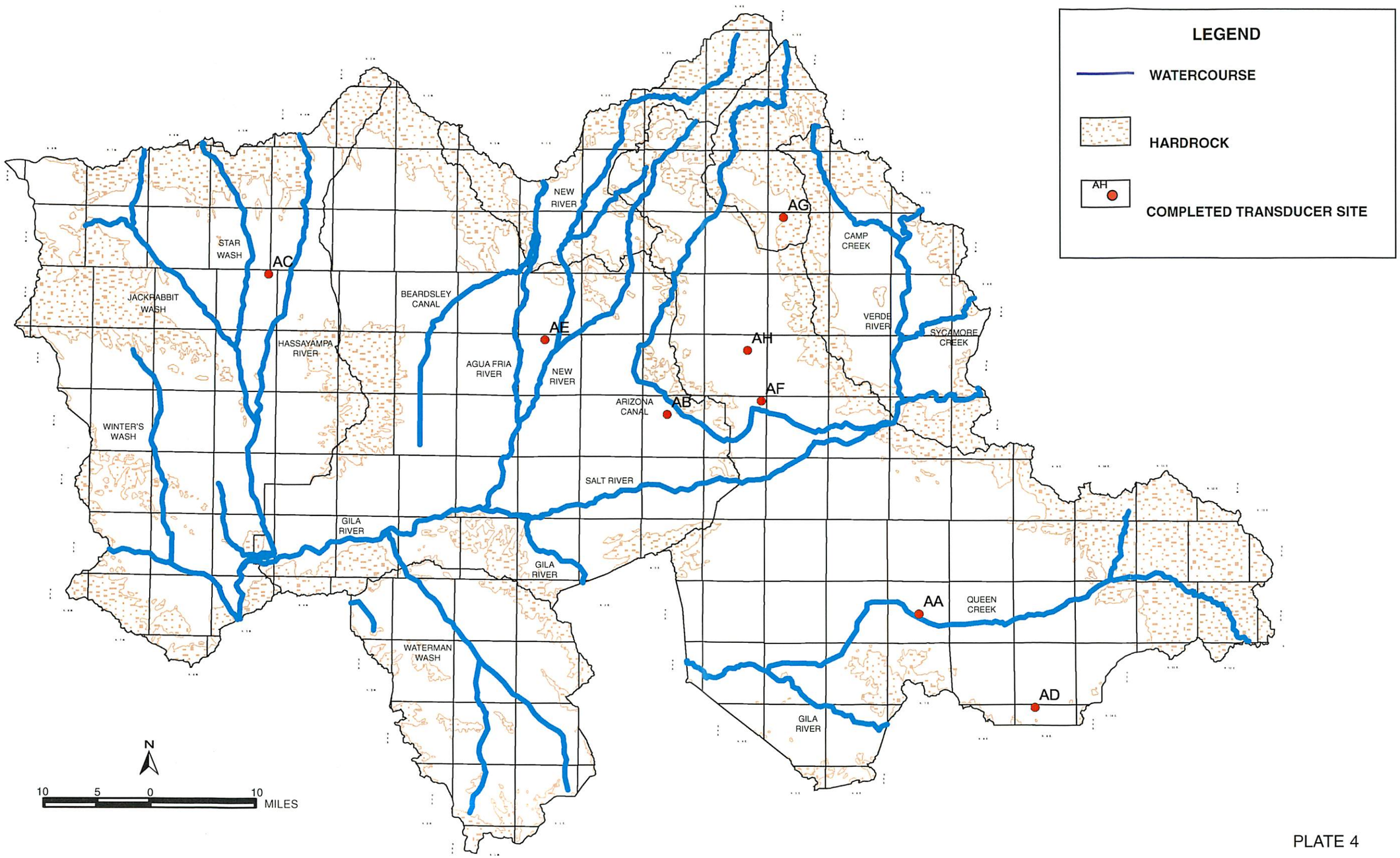



PLATE 4

MAP OF PHOENIX AMA ILLUSTRATING WATER LEVEL ELEVATION CHANGES (IN FEET) FROM 1995 TO 2000

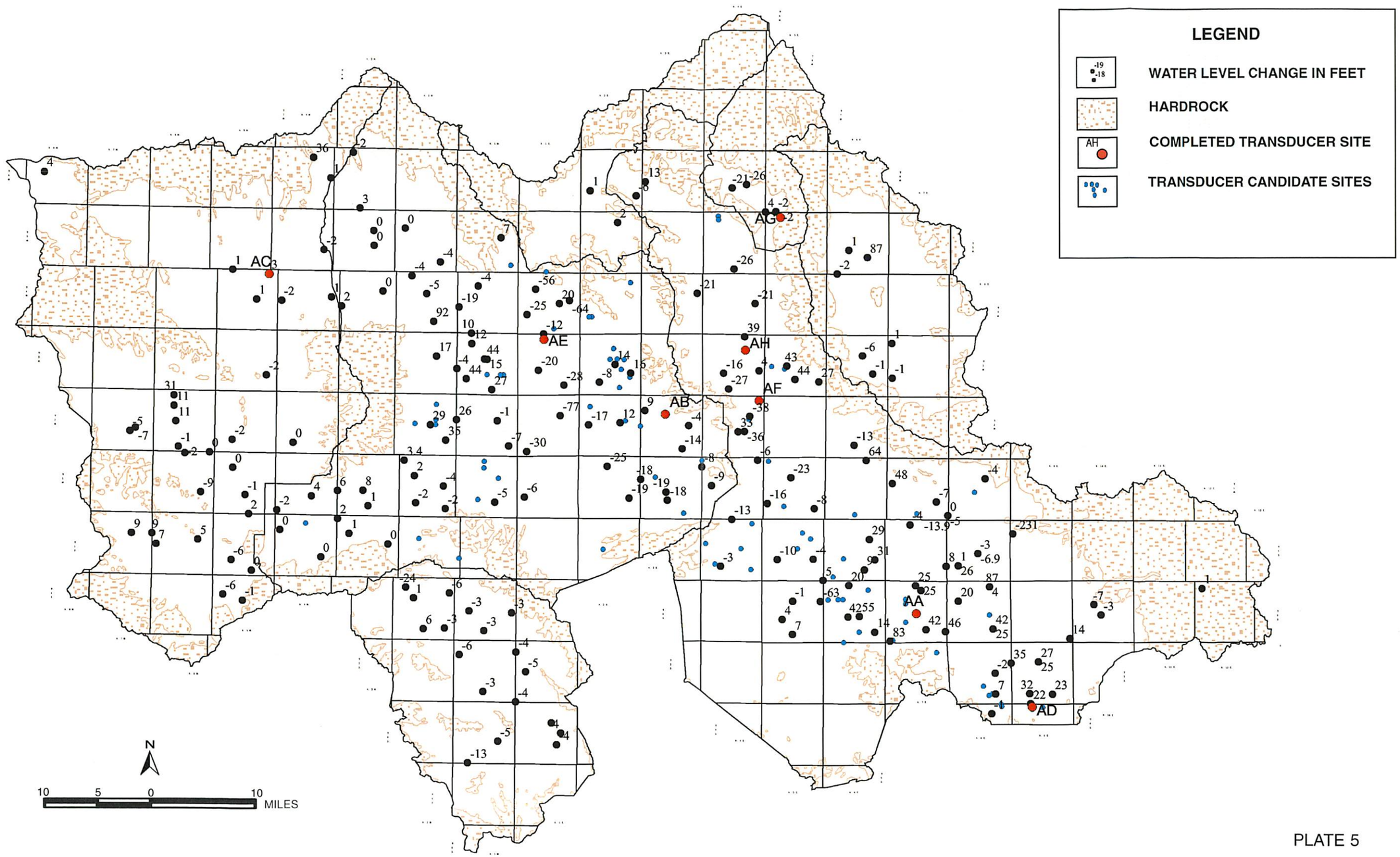
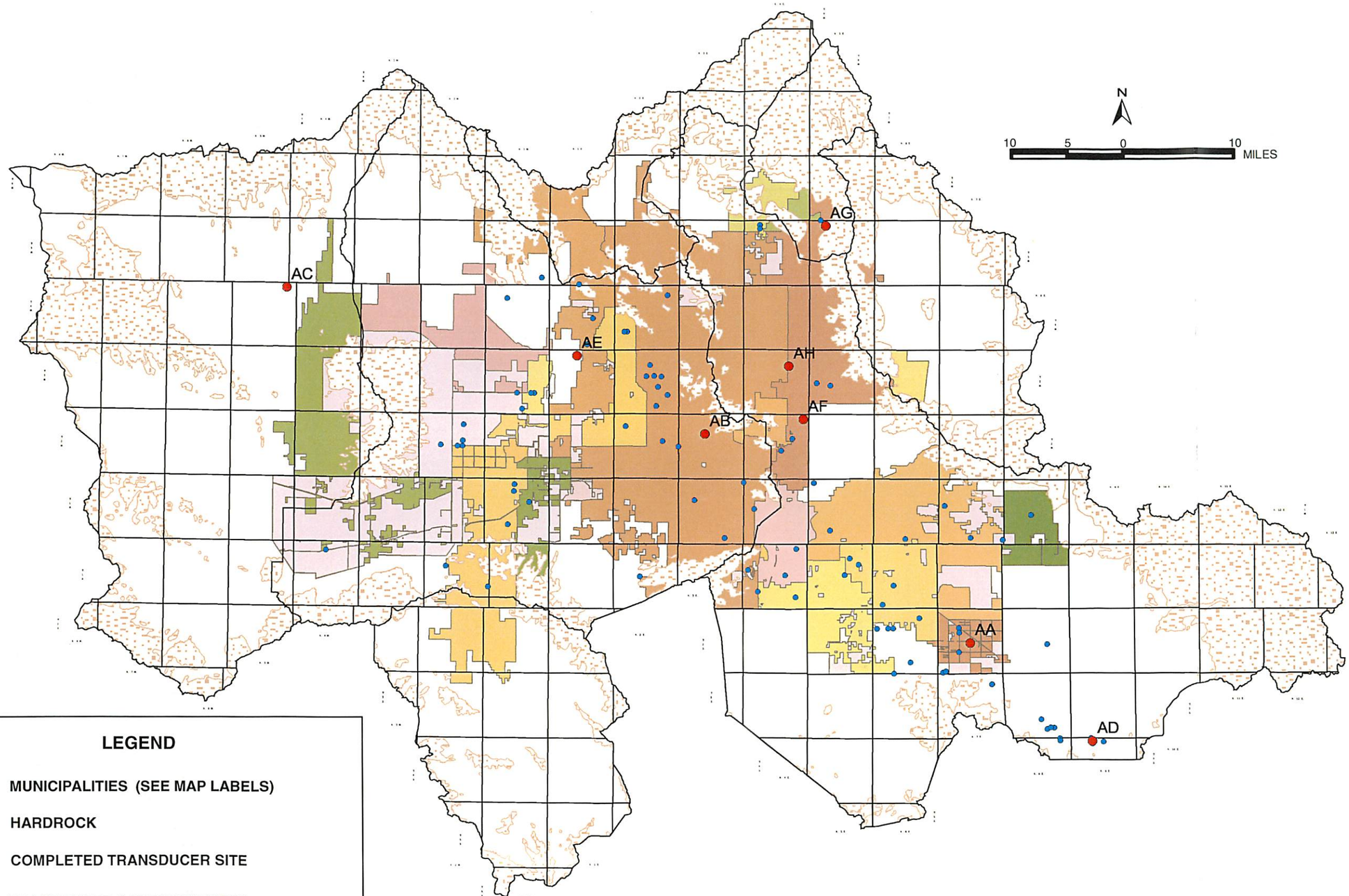



PLATE 5

MAP OF PHOENIX AMA ILLUSTRATING POLITICAL BOUNDARIES, CURRENT AND CANDIDATE TRANSDUCER LOCATIONS




MAP LABELS

- APACHE JUNCTION
- AVONDALE
- BUCKEYE
- CAREFREE
- CASA GRANDE
- CAVE CREEK
- CHANDLER
- EL MIRAGE
- FOUNTAIN HILLS
- GILBERT
- GLENDALE
- GOODYEAR
- GUADALUPE
- LITCHFIELD PARK
- MESA
- PARADISE VALLEY
- PEORIA
- PHOENIX
- QUEEN CREEK
- SCOTTSDALE
- SUPERIOR
- SURPRISE
- TEMPE
- TOLLESON
- URBAN LANDS OUTSIDE
- YOUNGTOWN

**LEGEND**

- MUNICIPALITIES (SEE MAP LABELS)
- HARDROCK
- AH COMPLETED TRANSDUCER SITE
- TRANSDUCER CANDIDATE SITES

PLATE 6

MAP OF PHOENIX AMA ILLUSTRATING SUBSIDENCE ZONES, TRANSDUCER SITES, AND CANDIDATE SITES

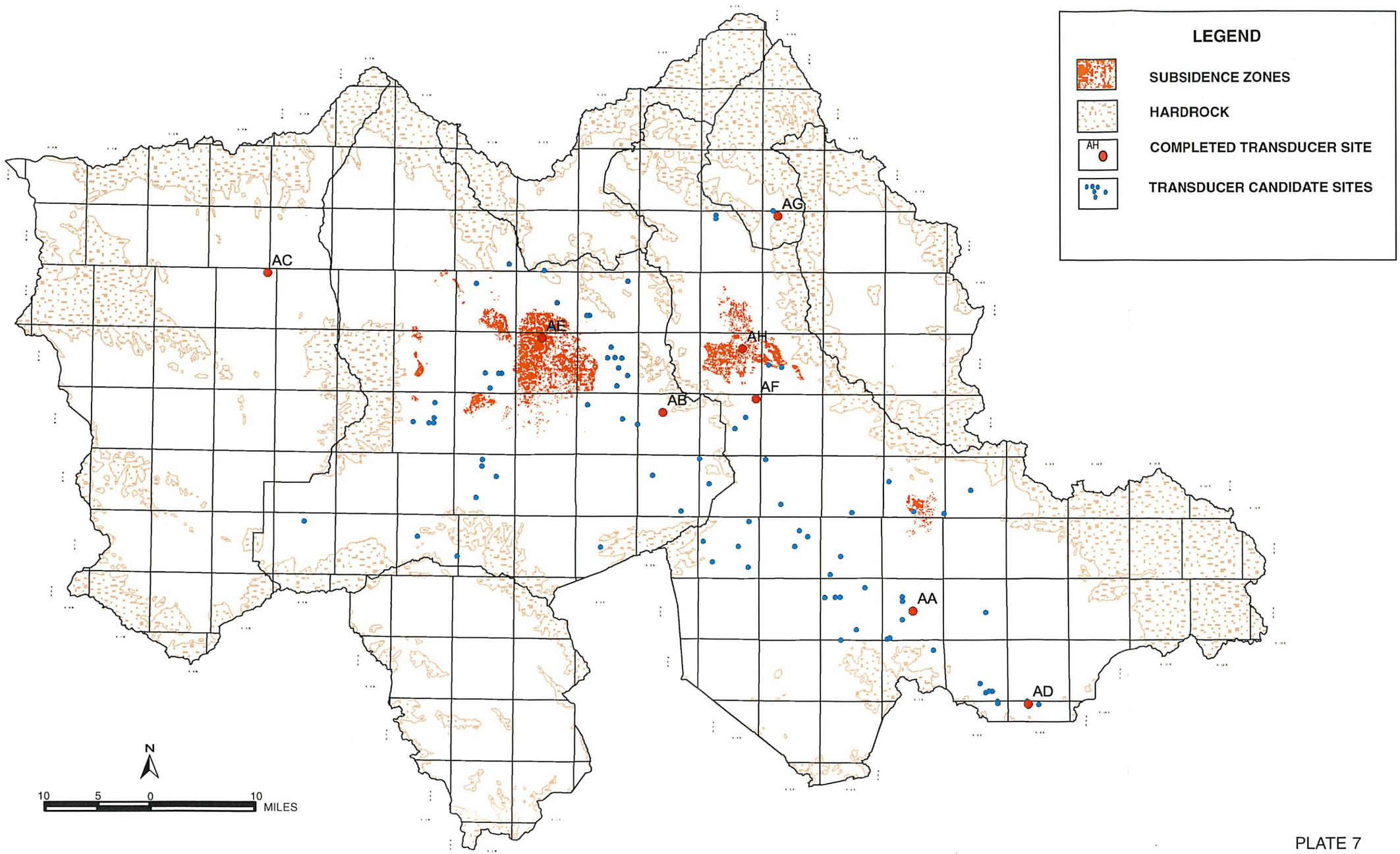



PLATE 7

MAP OF PHOENIX AMA ILLUSTRATING RECHARGE PROJECT LOCATIONS

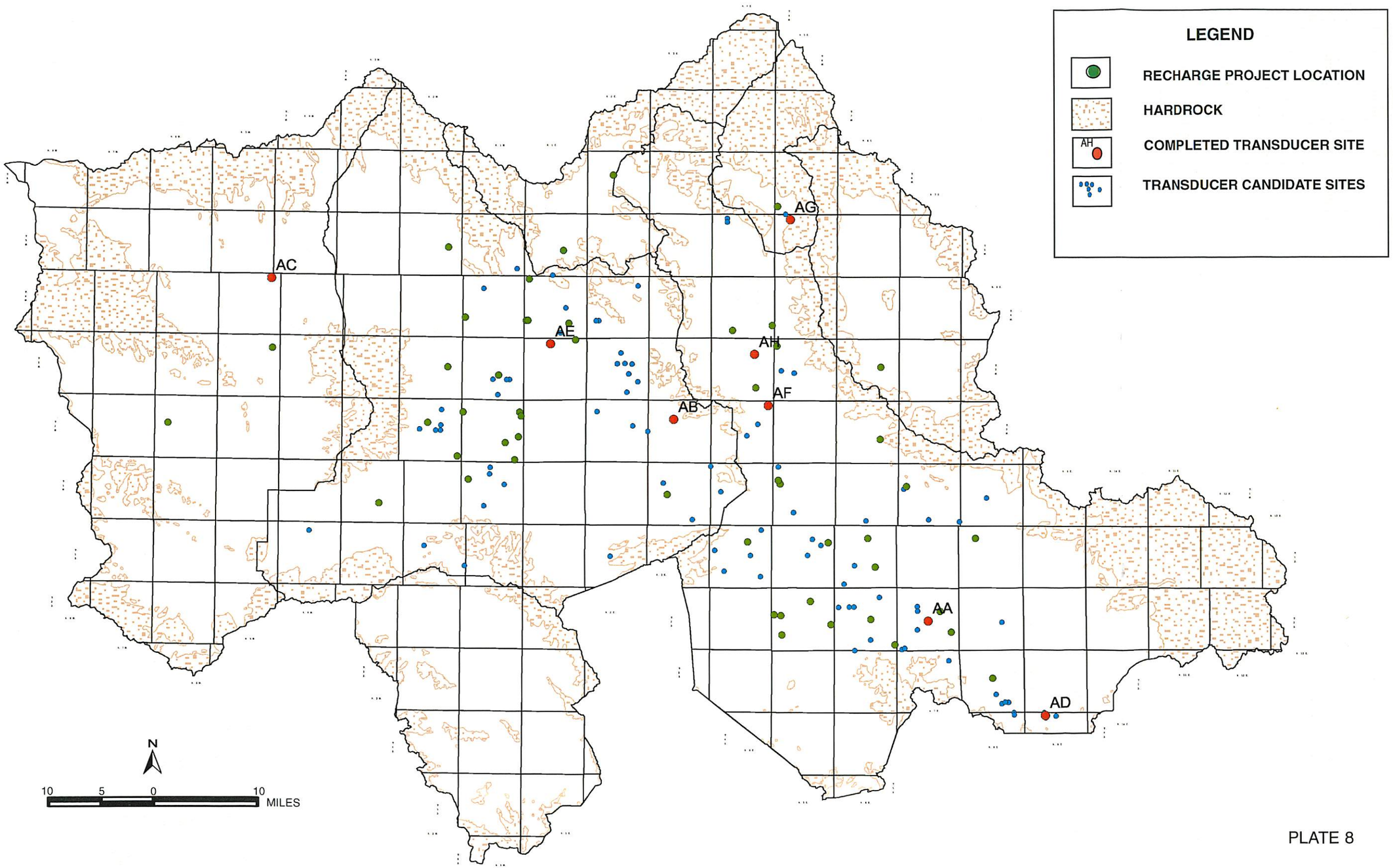
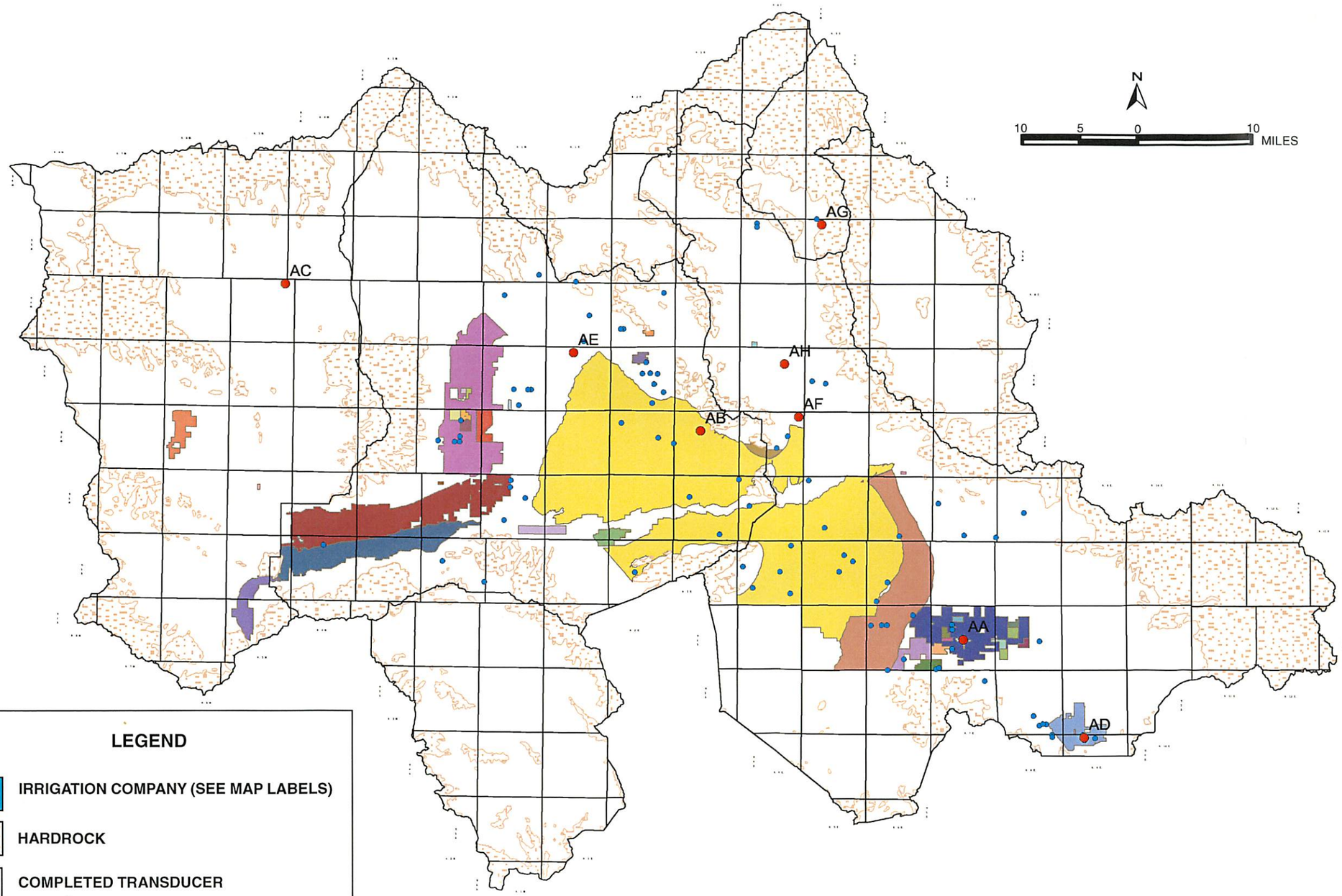



PLATE 8

## MAP OF PHOENIX AMA ILLUSTRATING IRRIGATION COMPANIES




### MAP LABELS

- 100 Coop
- 200 Coop
- Adaman IWDD #36
- Arabian Farms Association
- Arcadia Water Company
- Arlington Canal Company
- Buckeye Water Conservation and Drainage District
- Chandler Heights Citrus ID
- Citrus Glen OAI
- Citrus Heights Ranch
- Clearwater Farms I
- Clearwater Farms II
- Country Farms IMC
- Estrella Meadow Water Coop
- Hassayampa Water Coop
- Maricopa Water District
- New Magma Irrigation and Drainage District
- Olive Avenue HA
- Orangewood Farms
- Peninsula Ditch and Irrigation District
- Queen Creek ID
- Queen Creek IWDD
- Queen Creek Suburban Ranches
- Ranchos Jardines IDD
- Roosevelt Irrigation District
- Roosevelt Water Conservation District
- Saint Johns Irrigation District
- Salt River Valley Water Users Association
- San Tan ID
- Suburban ID
- Sun Valley Farms II
- Sun Valley Farms III
- Sun Valley Farms IV
- Sun Valley Farms VII
- Sunburst Farms Irrigation District
- Tonopah Irrigation District
- Western Meadows Irrigation District

### LEGEND

- IRRIGATION COMPANY (SEE MAP LABELS)
- HARDROCK
- AH — COMPLETED TRANSDUCER
- TRANSDUCER CANDIDATE SITES

PLATE 9

MAP OF PHOENIX AMA ILLUSTRATING EPA SUPERFUND AND WQARF SITES

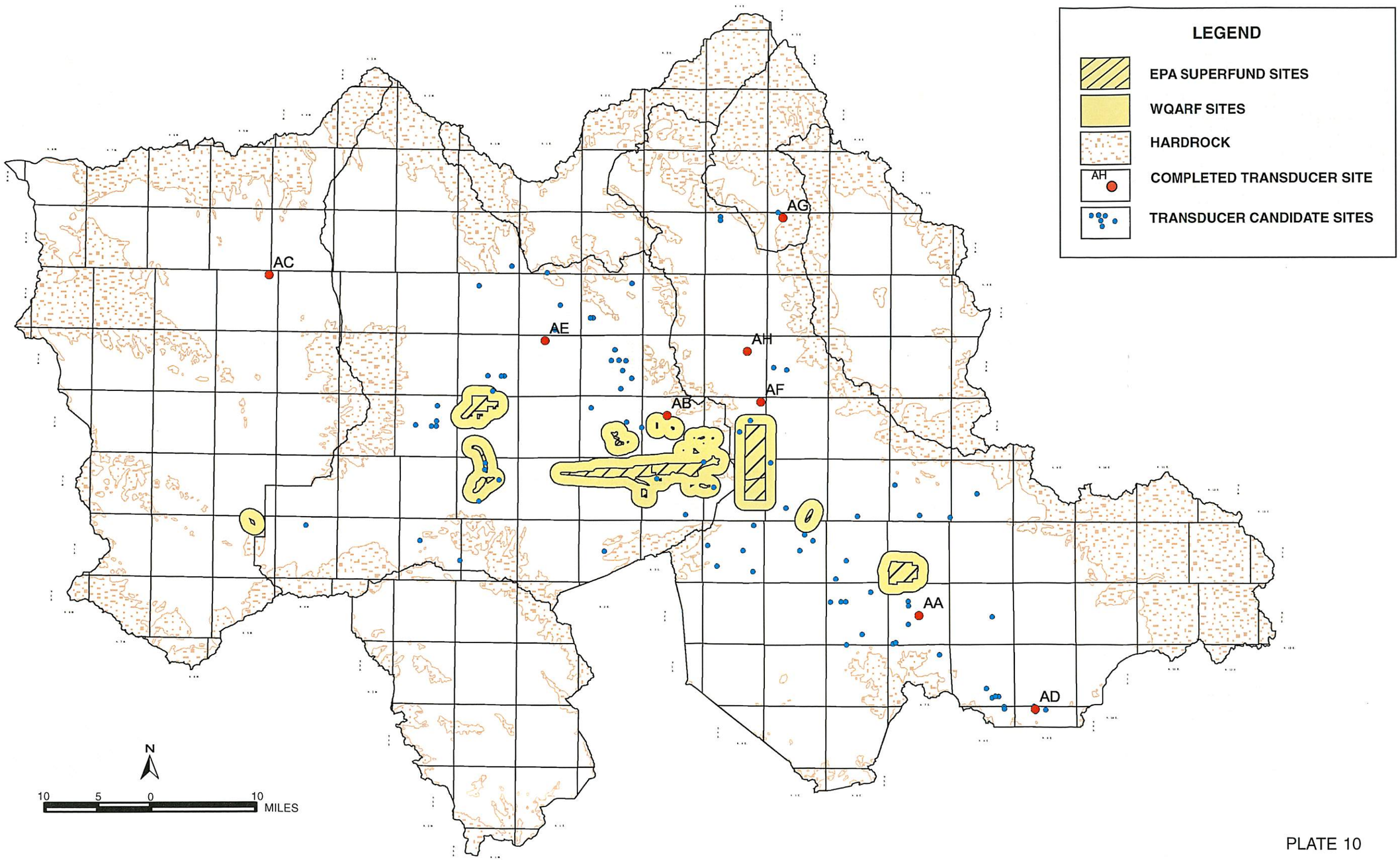



PLATE 10